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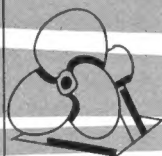
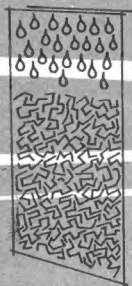
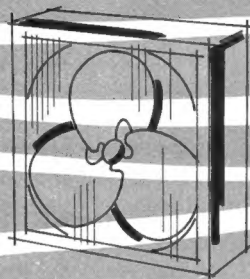
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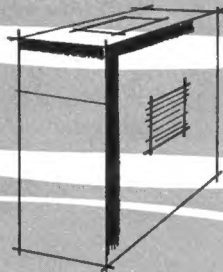
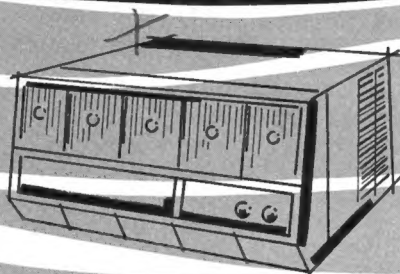
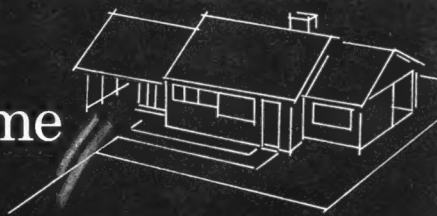
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# Equipment for Cooling Your Home



# EQUIPMENT FOR COOLING YOUR HOME

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Prepared by the Agricultural Engineering Research Division,  
2 U.S. Agricultural Research Service, + 2a

It has been a hot, summer day—and since early afternoon the inside of your house has been hot. Now the sun has gone down, and outside the temperature has dropped a little. Inside, though, your house remains just as hot as it was—hotter now than outside.

You open windows, but that doesn't help much because the air is calm and there is practically no circulation, no exchange of inside air for outside air.

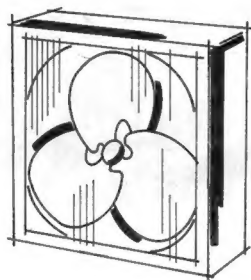
If you had some type of air cooling, you think, it would be better. And you decide to do something about that. You decide to cool your home mechanically—so it will stay comfortable during the day and be cool at night.

There are four ways, you learn, to cool your home:

- With fans.
- With water.
- With an air conditioner.
- With a heat pump.

Which way you choose will depend on how much you are willing to invest, both initially and in operating expenses, and on the climate of your community.

## Cool With Fans



You can buy two types of cooling fans:

- Room fans.
- Attic and window fans.

Room fans stir up the air. The temperature inside your house can be several degrees cooler than outside, but it can seem warmer if the air doesn't move. Also, air movement increases moisture evaporation, and moisture evaporation cools the air.

A good room fan has large blades, turns at about 1,000 r.p.m. (it may have a speed adjustment), operates quietly, and has an oscil-

lating mechanism. It will cost from \$35 for a table model to \$45 for a 7-foot, pedestal floor model. (Price ranges given in this bulletin are based on average 1963 retail prices.)

Attic and window fans exchange inside air for outside air. You can use them for night cooling, or whenever the temperature inside your home is greater than the temperature outside. When you have cooled your house at night, keep the windows and doors closed during the next day as long as it is cooler inside than out.

You will find that window fans are easier to install than attic fans—no construction is required—but you will also find that they are usually noisier.

Fans are rated by the amount of air they move in cubic feet per minute (c.f.m.). But there are several different tests for determining that rating and a single fan

may have as many as four different c.f.m. ratings from four different tests.

Determining the size of the attic or window fan you will need for your house requires the help of an engineer (some retail firms provide this service). The air inlets and outlets, the horsepower of the fan motor, and the revolutions per minute of the fan blade must be taken into consideration. You can, however, determine the approximate size yourself and probably get satisfactory results.

To determine the size fan you will need—

- Find the volume of the area you want to cool. Multiply the length of the rooms by the width. Then multiply that by the height.

- If you live in the dotted area of the map (fig. 1), divide the volume by 1.5. This will give you a minimum c.f.m. requirement. If you live in the undotted area, your

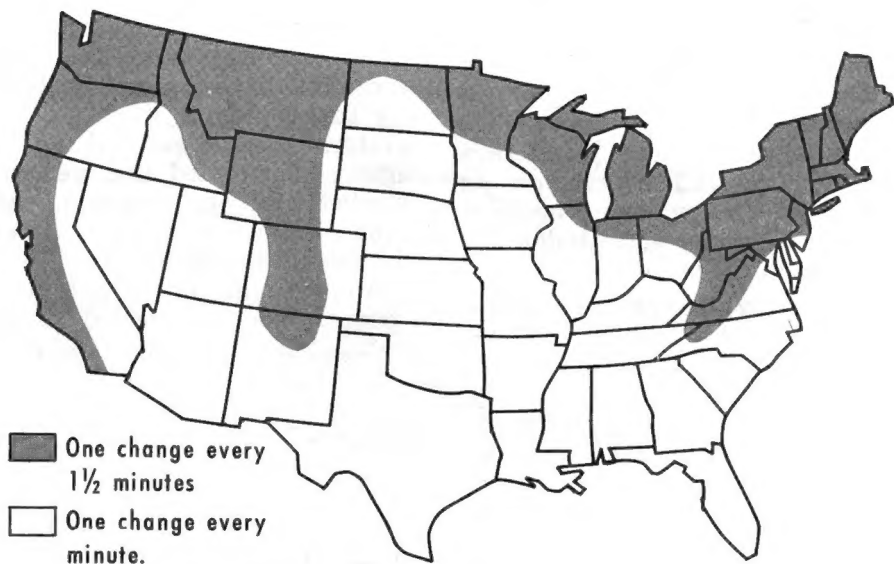


Figure 1.—Minimum air changes recommended for fan cooling.

minimum c.f.m. requirement will be the same as the volume you want cooled.

● Pick a fan that has a c.f.m. rating larger than your c.f.m. requirement—a larger rating will allow for slight differences in test procedure and efficiency.

If you choose a fan that is driven with pulleys and a belt, rather than one that is driven directly by the motor, the size of the pulleys can be varied slightly to adjust the amount of air moved. Models with two- and three-speed motors are also available.

Normally, a  $\frac{1}{3}$ -horsepower, 30- to 36-inch attic fan will provide 40 air changes per hour for the average 3-bedroom house. This is sufficient ventilation in the dotted area. Such a fan will cost from \$60 up.

A larger attic fan is required in the undotted area—a  $\frac{1}{2}$ - or  $\frac{2}{3}$ -horsepower, 36- to 42-inch fan that will normally provide 60 air changes per hour for the average 3-bedroom house. It will cost from \$70 up.

Window fans are usually smaller. They range in size from 20 to 30 inches. The 20-inch size is the most popular. It will generally provide about 23 air changes per hour for the average 3-bedroom house. Twenty-inch window fans cost from \$20 up.

You can also remove accumulated attic heat during the day with an attic fan. Often an attic is 25° or more hotter than outside; even if the ceiling of your house is insulated, this additional heat will warm your house.

When you remove attic heat with an attic fan during the day, close the attic off from the rest of your house. Otherwise the fan

will draw hot, outside air into your house.

Suppose you decide to cool your home with water or air conditioning, but wish to ventilate the attic anyway. A fan—smaller than an attic fan—will do that; it should be capable of changing the air in the attic at least once per minute, and should operate continuously when the temperature in the attic exceeds 110°. It may be controlled by thermostat, time clock, or manual switch. Such a fan will cost about \$50.

Cooling with fans has some disadvantages. Dust and pollen are likely to be drawn into your home. Fans are noisy. The cost of a good fan plus installation may be as much as a room air conditioner. And remember, a fan will cool your house to only approximately the temperature of the outside air.

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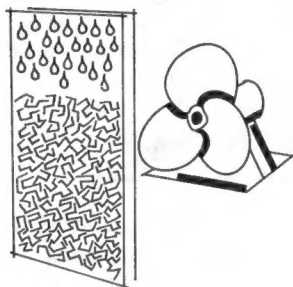
## HOUSE DESIGN

Good design and construction are as necessary to keeping your house cool in the summer as they are to keeping it warm in the winter. The house should be tightly constructed and well insulated. In the summer, the windows should be shaded from the direct rays of the sun.

A more comprehensive discussion of house design, insulation, and cooling equipment appears in USDA Agriculture Handbook 241, "Farmhouse Design and Equipment for Summer Comfort." This publication is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, at 15 cents per copy.

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# Cool With Water



You will find two common methods of cooling with water. They are—

- The water - evaporation method.
- The roof-spray method.

Cooling by water evaporation is satisfactory only when the humidity is low. It is used extensively in hot, dry climates. Figure 2 shows the area of the United

States where water-evaporation cooling is satisfactory.

Water is sprayed on excelsior (or some other good water-absorptive material). A fan then draws air through the excelsior. The water in the excelsior evaporates and cools the air; the cooled air, in turn, cools your home.

An air velocity of 200 to 300 feet per minute through the excelsior is necessary to keep the circulated air from becoming saturated. Twenty to 40 house-air changes per hour are necessary.

Water-evaporation cooling requires 5 to 10 gallons of water per hour to cool an average-size house.

Installation and operation costs for a water-evaporation cooling unit that is large enough to cool an average-size house will depend on your locality. A portable, single-room unit costs from \$30 up.

Roof spray is generally the least efficient method of cooling your

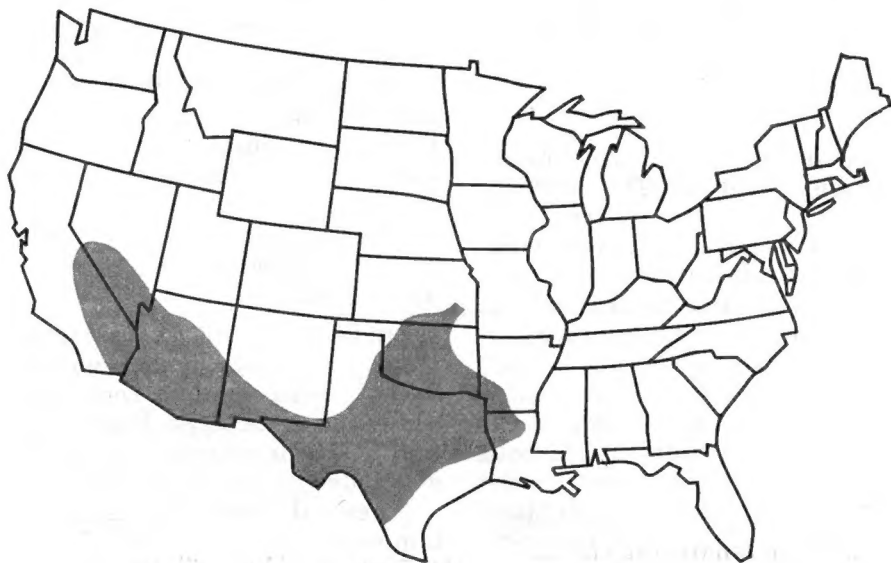


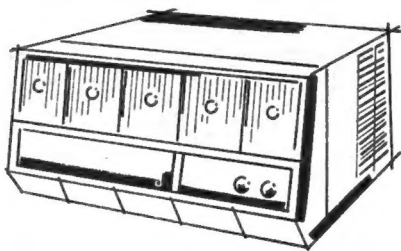
Figure 2.—Shaded area indicates where water-evaporation cooling is effective.

house. Abundant, economical water must be available.

Roof-spray cooling works best on houses with uninsulated ceilings and flat or low-incline roofs. Water is pumped to and sprayed on the roof at a rate of  $\frac{1}{4}$  to  $\frac{1}{2}$  gallon per square foot per hour. On a house 25 by 40 feet, that's at least 250 gallons of water per hour.

Equipment costs for roof-spray cooling include the price of a pump, pipe, and spray nozzles. Even if you have your own well, operation costs can be high.

## Cool With an Air Conditioner



Is air conditioning the answer to cooling your house? Certainly it is the best way to keep your house at a constant, cool temperature. But it is also more expensive than other methods of cooling.

There are two types of air conditioners—

- Room units.
- Central-system units.

The cooling operation of both types of air conditioners is the same. Air passes through filters that remove large dust particles, and over a series of refrigeration coils where it is cooled and dehu-

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midified. A fan then blows the cooled air into your home.

Most air conditioners have either built-in thermostats or provisions for wiring the conditioners to remote temperature controls. Some of the small units are not thermostat equipped, but you may find that a thermostat is available as optional equipment.

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Room air conditioners cool one or two rooms. They range in output from about 6,000 to 30,000 B.t.u.'s per hour. They operate on electricity only, and should have separate electrical circuits (this may require adding a circuit to your home).

You can choose from many available models—models for conventional windows, models for casement windows, models for in-front-of-window consoles, and models that mount in special wall openings.

Prices of room air conditioners rated at 6,000 B.t.u.'s start at about \$185.

But before you buy a room unit, think. You will probably need several small units to cool your whole house. A single, large room unit will be less expensive, but it will not cool your home evenly.

A central air-conditioning system might be a better buy.

Central air-conditioning systems are generally more efficient than

room air conditioners. They also seem less noisy because they are located out of the living area.

Central air-conditioning systems can be separate systems with their own ducts, or they can be combined with forced-air heating systems.

Cooling requires a greater amount of air flow than heating. If you choose an add-on system it will probably be necessary to increase the fan capacity of your furnace, and it may be necessary to enlarge and even relocate the distribution ducts. Larger ducts also decrease the velocity of the cooled air and reduce the noise of air conditioning.

For greatest uniformity in room comfort conditions, cold air supply grilles should be high in walls or in the ceiling and hot air supply grilles should be near or in the floor. If economy dictates use of only one grille for both heating and cooling, the near floor location is preferred.

The cost of purchasing and installing a central air-conditioning system will depend, to a large extent, on whether you choose a separate central system, or a system to be added to your heating system. A central air conditioner rated at 34,000 B.t.u.'s that can be added to your forced-air furnace usually costs from \$700 to \$1,500 before installation.

Most room air conditioners have air-cooled condensers. This means that the condenser must be outside the cooled room, that it must have unrestricted air circulation over the condenser coils, and that it should be shaded from the sun.

Some air conditioners have water-cooled condensers. They require large quantities of water to

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Air conditioners are rated by heat-removing capacity in British thermal units (B.t.u.'s). Where temperatures do not usually exceed 95°, an air conditioner rated at 6,000 B.t.u.'s per hour will cool a room with 100 to 230 square feet of floor space. Where temperatures exceed 95° but do not exceed 100°, an air conditioner rated at 6,900 B.t.u.'s is required to cool the same area.

Approximately 1 kilowatt-hour of electricity is required to remove each 6,500 B.t.u.'s with an electrical air conditioner. This is the same amount of electricity that is required to operate ten 100-watt light bulbs for 1 hour.

A water-cooled gas air conditioner requires about 13 cubic feet of gas (plus a small amount of electricity) to remove each 6,500 B.t.u.'s. An air-cooled gas air conditioner requires 21 cubic feet of gas (plus a small amount of electricity) to remove each 6,500 B.t.u.'s.

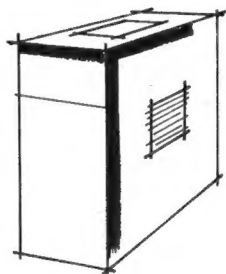
Central-system air conditioners are sometimes rated in "tons." One ton of refrigeration equals 288,000 B.t.u.'s per 24 hours, or 12,000 B.t.u.'s per hour.

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disperse the heat—approximately 75 to 150 gallons per hour for each 12,000 B.t.u.'s of cooling capacity. This water can be cooled in a cooling tower and reused. Locate the tower outdoors, away from your house; it is noisy.

Air-cooled units require more electric energy than water-cooled units. This increased cost is usually offset by water supply and disposal (or cooling tower) costs.

# Cool With a Heat Pump



Another method of air cooling you will want to consider is the heat pump. The heat pump is a single unit that replaces the conventional furnace-air conditioner

system. It removes heat from your home in the summer and supplies heat to your home in the winter.

The heat removed in the summer is discharged to the outside air.

Usually, the heat pump is sized to handle your summer cooling load and is supplemented with an auxiliary heater to handle part of your cold-weather heat load. A heat pump may cost more than a central furnace-air conditioning system. Operation costs, over a year's time, will depend on how much supplemental resistance heat is needed in the winter. In areas where little supplemental heat is needed, or where the cost of electricity is low, operation costs may be less than for conventional central furnace-air conditioning systems. In other areas, it may be higher.

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